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Electronic Time Fuze	Proximity Fuze
Functioning Time	Time Fuze
Fuzes	Time-to-burst

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Describes procedures for measuring time elapsed between the instant of firing (time zero) and the air-burst of the warhead.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATION PROCEDURE

DRSTE-RP-702-103
*Test Operations Procedure 4-2-808 1 June 1981
AD NO.

FUNCTIONING TIME OF AIR-BURST FUZES

1. SCOPE. This TOP describes procedures for measuring the elapsed time between the instant of firing (time zero) and the air-burst of a fuzed warhead. Weapon firing conditions such as elevation, zone, temperature, and sample size are covered in TOP 4-2-055.[1]**

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENT
Test site	include suitable weapons and observation points
Loading plant	high explosive and inert filler

*This TOP supersedes TOP/MTP 4-2-808, 30 April 1968.

**Footnote numbers correspond to reference numbers in Appendix C.

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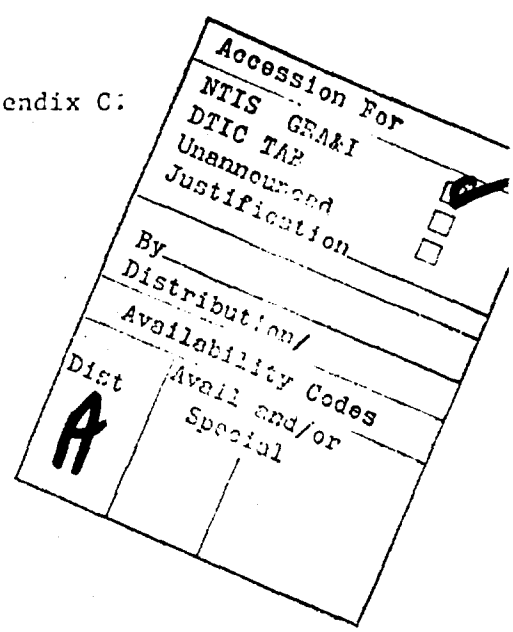


2.2 Instrumentation.

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT*
Infrared (IR) chronograph system (including IR detector pickup unit and amplifier, counter, power supply, and starter switch)	0.0001 second
Stopwatches	± 0.1 second
Projectile velocity-measuring equipment (TOP 4-2-805)[2]	± 0.1%
Weapon pressure-sensing device (TOP 3-2-810)[3]	± 2%

3. PREPARATIONS FOR TEST.

3.1 Planning.

a. Review the test requirements, and determine the number and types of rounds to assemble for the test.

b. Design data-collection sheets for recording round-by-round data as required by the particular test [see Appendix B for example].)

3.2 Weapon.

a. Select a weapon(s) for which the projectile(s) is standard and which has at least 75% of its service life remaining, unless otherwise specified in the requirements documents.

b. Stargage the tube as specified in TOP 3-2-802.[4]

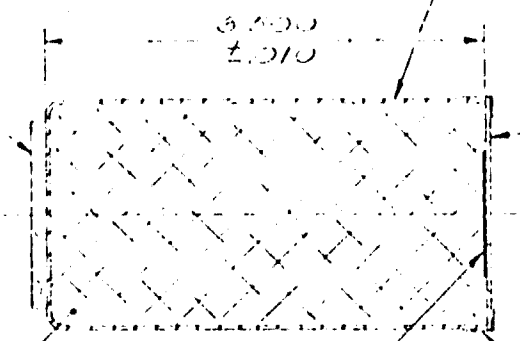
c. Firmly mount a starting switch (e.g., an inertia switch) on a recoiling component of the weapon to obtain zero time.

3.3 Ammunition.

a. Load service-type projectiles with inert material so that they have the same weight and density as the standard high-explosive filler.

b. Drill a cavity into the inert filler to accept one APG-2 spotting charge (see Figure 1). All testing to determine functioning time of air-burst fuzes should be conducted with an APG-2 spotting charge to ensure high visible and infrared light indications of in-flight functioning. (The T-2 charge has limitations since it may may not produce radiation levels sufficient to ensure reliable operation of the IR chronograph.)

*Values may be assumed to represent ± 2 standard deviations; thus, the stated tolerances should not be exceeded in more than 1 measurement of 20.



LOADED PROJECTILES.
FSN-1315-N00-0048-0093
MODIFY TO 3.5" LGTH. AS SHOWN.

FELT DISC. 1½ DIA. × 1/8 THK.
SEE NOTE 3

ALUMINUM DISC, .04 THICK × 1.351 DIA.
WITH ½ DIA. HOLE IN CENTER
SEE NOTE 2

SCOTCH TAPE
SEE NOTE 4

1" DIA. ONION SKIN PAPER
SEE NOTE 2

CHARGE: 1200 GRAINS (70%) PROPELLANT M9 COMP. .003 WEB, FLAKED
500 GRAINS (30%) ALUMINUM POWDER, ATOMIZED, TYPE C
CLASS D. FSN-1375-NO-75120-0400

NOTES:
1. BLEND IGNITION POWDER & ALUMINUM POWDER IN BATCH LOTS TO PRODUCE FROM 1700 GRAINS INTO ALUMINUM LINER.
2. SEAL HOLE IN ALUMINUM DISC WITH ONION SKIN PAPER USING DUPONT CEMENT.
3. SECURE FELT PAD TO BASE OF ALUMINUM LINER WITH DUPONT CEMENT.
4. SECURE ALUMINUM DISC TO TOP OF ALUMINUM LINER WITH SCOTCH TAPE.

SYM	DESCRIPTION	DATE	APPROVED

REVISIONS

PHYSICAL PROPERTIES

YP	
YS	
ELG	
RA	
BH	
BBN	

NEXT ASSY | USED ON

APPLICATION

DO NOT APPLY PART NO.
DO AS SPECIFIED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS
ANGLES FRACTIONS
MATERIAL STEEL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 11 JAN 65

DRAFTSMAN	CHECKER
TRACER	CHECKER
ENGINEER	ENGINEER

SUBMITTED
APPROVED BY ORDER OF THE

SPOTTING CHARGE
MODEL APG-2

SCALE 1/1 | UNIT WT

DEPT OF THE ARMY

DWG SIZE B | 05-[illegible]-2

SHEET OF

Figure 1.

3.4 Instrumentation. Install instrumentation to measure the following in accordance with the listed reference:

a. Muzzle velocity as described in TOP 4-2-805.
b. Weapon chamber pressure as described in TOP 3-2-810.

4. TEST CONTROLS. Do not test when atmospheric conditions would prevent visual observation.

5. PERFORMANCE TESTS.

5.1 Method.

a. Lay the weapon system to be tested in azimuth and elevation.

b. Set the fuze on the test system for the desired air-burst. (Fuze setting must be verified by a photograph or an observer.)

c. Lay four IR chronographs, as required, to sense detonation of the fuze. (Record the values for informational purposes only.) NOTE: The IR chronograph may be offset, and the azimuths and elevations computed to correspond to the spatial position of the air-burst; or, a spotter round that air-bursts the same as the test rounds may be used. The latter method requires that the IR chronograph be physically (manually) aimed to acquire the air-burst signature. NOTE: Azimuth and elevation settings for the IR chronographs may be computed, or if available, taken from records of previous firings. Orientation of the IR chronographs is critical, as the field of view of the lead sulfide cell is about 8 degrees in both azimuth and elevation.

d. Position observers with stopwatches to provide backup data to include verification of fuze functioning. Stopwatch functioning times are used to verify that nothing has spuriously triggered the chronographs. Stopwatch readings must not replace chronograph readings since their accuracy is not adequate for precise measurement.

e. Energize test equipment, and verify proper operation of components.

f. Fire the weapon, and record the time of firing.

g. Using the IR detectors, measure and record the time- to-burst.

h. Repeat steps a through g for various fuze settings, zone charges, projectile types, elevations, and temperatures (see TOP 4-2-055).

5.2 Data Required. Instrumentation personnel will record the following on data sheets as shown on pages B-2 and B-3:

a. Date of test
b. Round number
c. Test location
d. Chronograph readings (usually four) and average of readings
e. Stopwatch times
f. Instrumentation used
g. Gun switch number
h. Counter manufacturer, model, and serial number
i. Total number of rounds fired

recorded to four decimal places. The recorded time values for each round will be averaged, and the average rounded to the nearest 0.001 second, using the method prescribed by the American Society for Testing Materials (see ATP F-105H/55H/8H-IJ)[6]

The test director will record the following data:

a. Azimuth and elevation of weapon system being used chronographs (in degrees)
b. Meteorological conditions:

(1) Ambient temperature
(2) Relative humidity

c. Fuze type and lot number
d. Fuze setting
e. Time of firing of each test round
f. Weapon and barrel used
g. Zone charge of propellant
h. Temperature of ammunition
i. Pre-treatment of fuze/projectile (e.g., vibration)
j. Muzzle velocity*
k. Chamber pressure*

6. DATA REDUCTION AND PRESENTATION.

a. Using the data obtained by chronograph, determine the fuze time-to-burst to the nearest millisecond for each round. NOTE: The IR chronograph computes time-to-burst for all fuzes automatically from recorded data.
b. Compare time-to-burst data with the actual fuze settings, and determine whether times-to-burst occur within acceptable limits.
c. Determine mean of chronograph readings for each projectile firing. From these values, determine the mean and standard deviation of fuze functioning time for each condition of fuze setting, zone charge, fuze temperature, elevation, and weapon, as shown on page B-1.

*NOTE: These items are taken only when specifically requested to gain additional information.

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APPENDIX A

INSTRUMENTATION

IR Fuze Chronograph.

Time of flight of air-burst fuzes may be obtained with several types of instrumentation. Of these, the infrared (IR) fuze chronograph system is preferred for fuze timing because of its accuracy, simplicity of operation, and immediate data availability. The IR fuze chronograph system is a heat /light-sensitive device that detects burst flashes from artillery and rocket ammunition at short and extremely long slant ranges, and converts these flashes into a signal suitable for a time counter recording. The IR chronograph system consists of four basic components (see Figure A-1):

1. The power supply for use with the IR chronograph operates from a 115-volt, AC source.
2. The starting switch, the means of identifying the instant of firing (time zero), is an inertia-type switch mounted (strapped or clamped) on the weapon.
3. The IR detector or pickup unit is an 8- by 8-mm lead sulfide photoconductor (cell) mounted in the focal plane of a 15-cm parabolic reflector, both supported within a tubular housing. The housing, in turn, is mounted between trunnions on a traversing base to permit 90° elevation and 360° traverse. The entire assembly can be mounted on a rigid permanent mount or on a suitable tripod for portable operation. The output of the detector cell is fed into the amplifier that operates the counter.
4. The counter on which the times are read is a standard commercial unit. It is mainly an automatic recording counter consisting of a series of counting circuits with an inherent accuracy of $\pm$ 10 microseconds. When the weapon is fired, the circuit is energized, starting the counter, and the elapsed time is recorded on the counting circuits. One advantage of the timer is the speed with which the fuze functioning time interval can be reported.

The IR system is known to be effective for a slant range of 15,000 meters for daylight firing. With a portable IR system down range, the range can be effectively extended to far greater ranges from the weapon. The IR system is of optimal effectiveness in the daytime, when projectiles are loaded with charges especially developed for recording air-burst fuze times. The IR system sensing equipment can be adjusted to preclude erroneous triggering by spurious background signals. A typical fuze chronograph system is shown in Figure A-2.

Other Methods.

Other means of obtaining time-to-burst data include a photographic method and telemetry. These are costly and involve a considerable amount of instrumentation. For tests that do not require a high degree of accuracy, stopwatches or a system of electric clocks with a good time resolution of

0.01 second may be used. The clocks are started and stopped manually by observers.

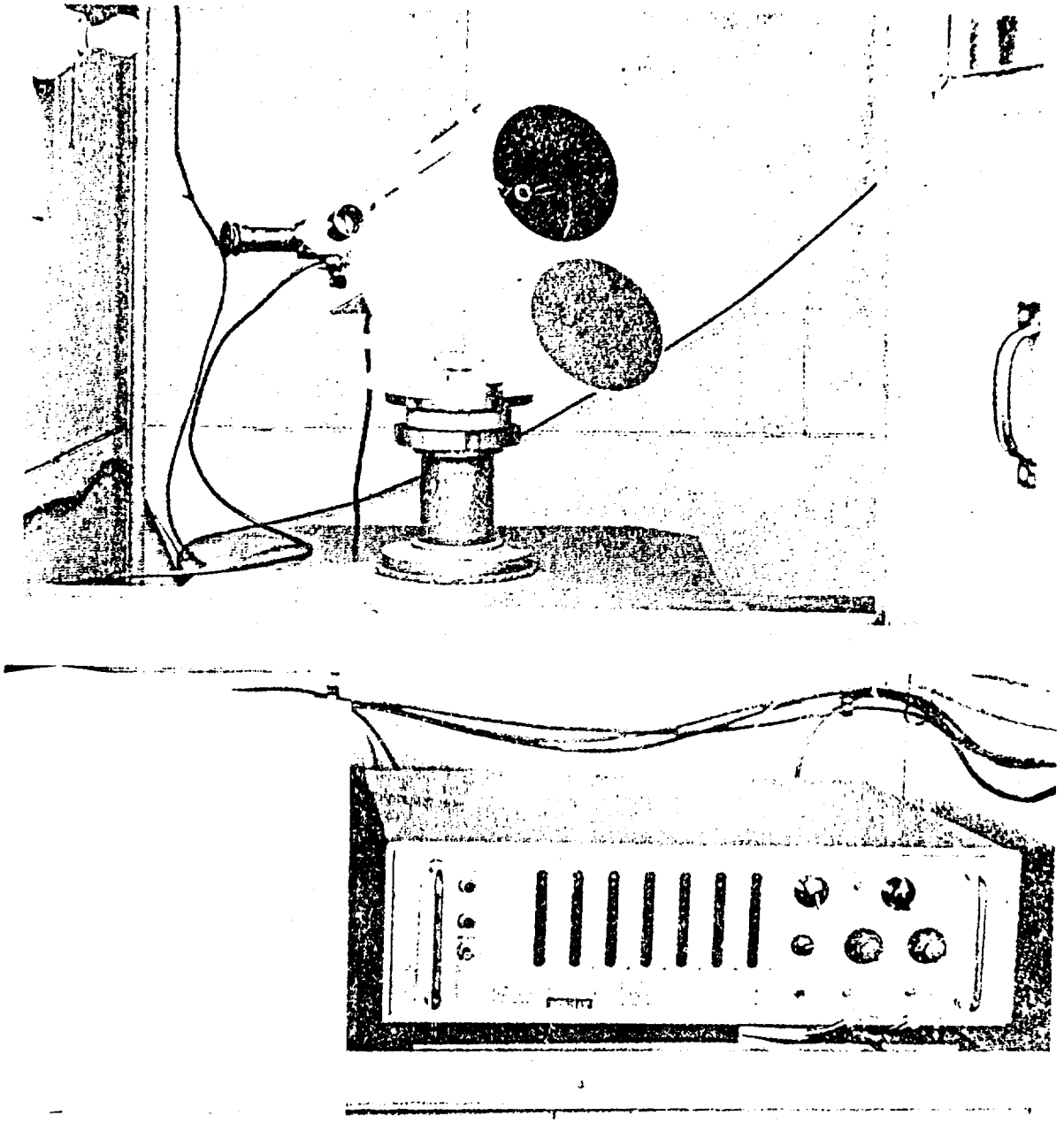

Figure A-1. The Infrared Fuze Chronograph

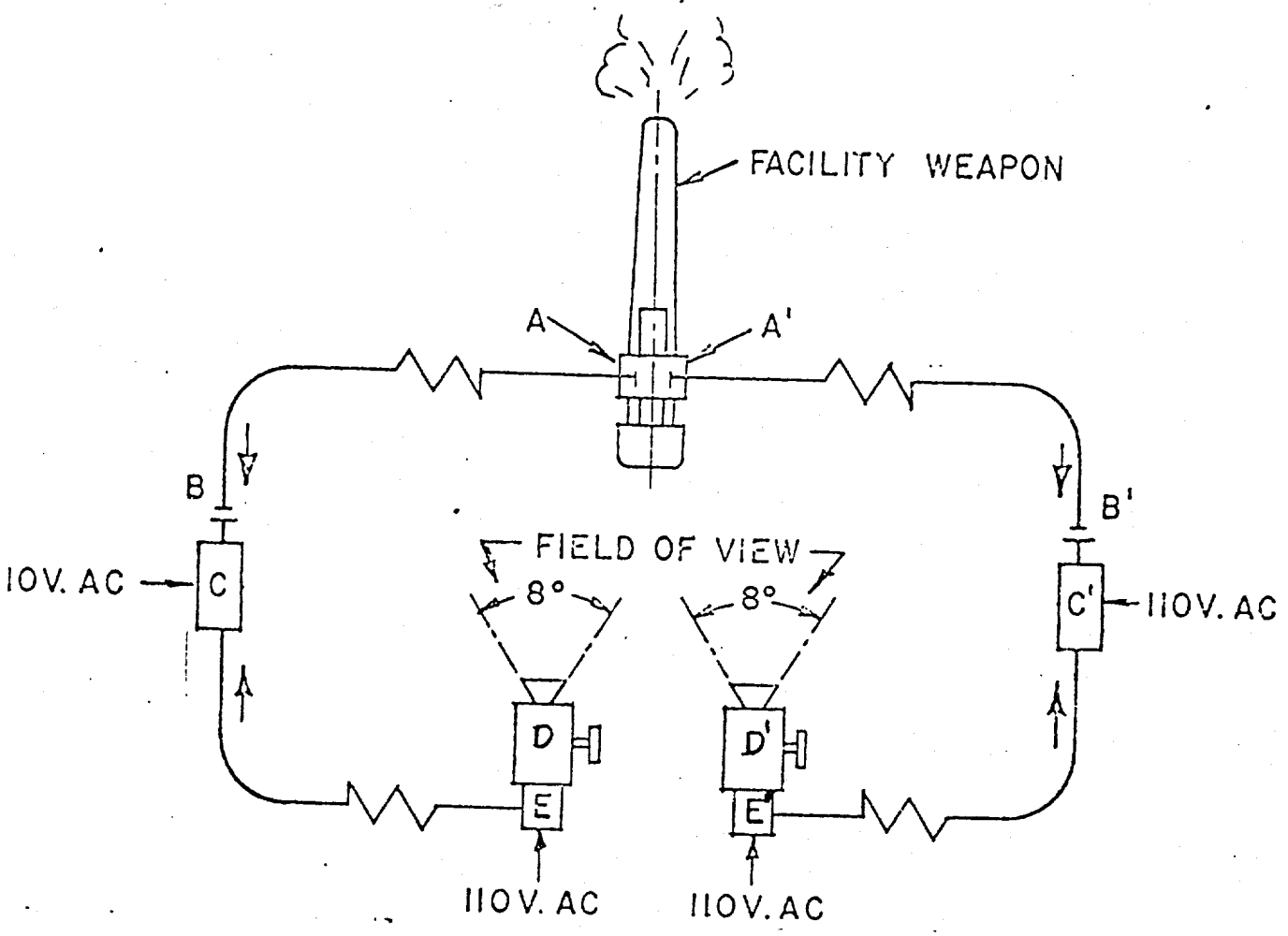

Figure A-2. Schematic Diagram of Infrared Fuze Chronograph System (Dual Arrangement)

A and A' Inertial Type Switch: Actuated on recoil of facility weapon to start counter.

B and B' Power Pack: 24-volt d-c unit adjacent to counter.

C and C' Chronograph Counter

D and D' IR Detector Unit: Actuated by projectile burst to stop counter.

E and E' Amplifier: Integral part of detector unit

APPENDIX B

SUMMARY OF DATA (EXAMPLES)
SUMMARY OF FUNCTIONING TIME PRECISION

Group No.	Weapon	Temp, °F	No. of Rds Fired	No. of Rds Cons	Fuze Set Time, sec	Time to Function, sec Avg	Time to Function, sec Std Dev
1	4.2 mort, M30	- 40	10	10	14.0	14.04	0.044
2	8-in. how, M110	- 40	10	10	25.0	24.99	.023
3	8-in. how, M110	+ 70	10	10	20.0	20.03	.030
4	155 how, M109A1	+ 70	10	[a] 9	25.0	25.02	.017
5	155 how, M109A1	+ 70	10	10	25.0	25.04	.094
	155 how, M109A1			[b] 9	-	25.01	.035
5	155 how, M109A1	- 40	10	10	25.0	25.03	.125
	155 how, M109A1			[b] 9	-	24.99	.036
6	155 how, M109A1	+145	10	10	25.0	25.04	.032
7	105 how, M102	+ 70	21	[a]14	50.0	50.00	.022
7	105 how, M102	- 40	10	[a] 9	50.0	49.95	.092
7	105 how, M102	+145	10	[a] 9	50.0	50.00	.034
8	155 how, M109A1	+ 70	10	10	33.0	32.99	.030
8	155 how, M109A1	- 40	10	10	33.0	32.98	.023
8	155 how, M109A1	+145	10	10	33.0	33.02	.034
9	155 how, M109A1	+ 70	10	10	30.0	30.10	.307
	155 how, M109A1			[b] 9	-	30.00	.020
10	155 how, M109A1	- 40	10	[a] 8	50.0	49.93	.037
10	155 how, M109A1	+145	10	[a] 9	56.8	56.79	.027
11	155 how, M109A1	+ 70	20	[a]17	72.0	71.97	.032
12	155 how, M109A1	+ 70	10	10	57.0	57.01	.088
	155 how, M109A1			[b] 9	-	56.98	.027
13	155 how, M109A1	No ir times obtainable					
14	155 how, M109A1	+ 70	12	[a] 9	50.0	50.03	.031
14	155 how, M109A1	+ 70	7	[a] 5	55.0	55.00	.033
15	155 how, M109A1	+ 70	20	[a]17	55.0	54.97	.031
16	105 how, M102	+ 70	10	[a] 8	50.0	49.99	.031
16	105 how, M102	+ 70	8	8	50.0	49.98	.036
16	105 how, M102	- 40	8	[a] 7	50.0	49.99	.188
16	105 how, M102			[b] 6	-	49.92	.036
16	105 how, M102	+145	8	[a] 6	50.0	50.01	.034
17	105 how, XM204	+ 70	5	5	45.0	44.99	.034
17	105 how, XM204	+ 70	5	5	46.5	46.47	.011
17	105 how, XM204	+145	10	[a] 9	46.5	46.57	.190
17	105 how, XM204			[b] 8	-	46.51	.037

[a]Time missed on remaining round(s).
[b]Omitting one round.

DATA SHEET

1. TITLE: (SOP 10-1-7) FUZE FUNCTION TIME MEASUREMENTS (in seconds)				2. Date: 7/15/80	3. Sheet 1 of 1
				4. Fuze Lot No. MAS80E001S001	5. Fuze Setting: 6 sec.
6. Test Director: P.O. Steier				7. Weapon: 35 mm	8. Location: B659
No.	10. #1 Fuze Chron	11. #5 Fuze Chron	12. #8 Fuze Chron	13. #2 Fuze Chron	14. average Fuze Chron	15. Stop Watch	16. Remarks
1	---	---	---	---	---	---	
2	---	---	---	8.5941	8.594	8.55	
3	9.1810	---	9.1975	9.1620	9.180	9.19	
4	8.7151	8.7152	---	8.7151	8.715	8.70	
5	8.3431	8.3427	---	8.3427	8.343	8.33	
6	---	2.6856	2.6881	2.6894	2.688	2.71	
7	---	---	8.8881	---	8.888	8.92	
8	9.1700	9.1695	9.1695	9.1694	9.170	9.20	
9	---	1.5573	1.5621	---	1.560	1.60	
10	9.1350	9.1347	9.1351	9.1352	9.135	9.14	
11	8.9601	8.9611	8.9281	8.9927	8.960	9.90	
12	---	---	---	9.0997	9.100	9.20	
13	8.8651	8.8468	8.8472	8.9000	8.865	9.15	
14	----	-----	---	---	----	----	NFS
15	6.9550	6.9383	6.9653	6.9624	6.955	7.0	
16	8.4872	8.4835	8.4861	8.4901	8.487	8.75	
17	8.5621	8.5618	8.5617	8.5617	8.562	8.57	
18	-----	-----	----	3.1917	3.192	3.27	
19	9.2530	9.2521	9.2540	9.2525	9.253	9.34	
20	8.9551	8.9304	8.9378	8.9971	8.955	9.15	
21	9.1840	9.1802	9.1824	9.1900	9.184	9.29	
22	----	-----	-----	---	-----	-----	NFS
23	7.6220	7.6089	7.6060	7.6504	7.622	7.85	
24	----	----	-----	-----	----	-----	NFS
25.	8.8040	8.8068	8.8040	8.8020	8.804	8.92	

DATA SHEET

1. TITLE: RG. ENGR. SOP 10-1-7B FUZE FUNCTION EQUIPMENT UTILIZATION	2. DATE
	3. WEAPON
4. TEST DIRECTOR:	5. LOCATION

6. INSTRUMENTATION USED	A. NO. FUZE CHRON	B. NO. FUZE CHRON	C. NO. FUZE CHRON	D. NO. FUZE CHRON
GUN SWITCH NUMBER				
COUNTER MANUFACTURER				
COUNTER MODEL				
COUNTER SERIAL NUMBER				
TOTAL ROUNDS FIRED				

AP Form 1013, 5 Feb 68 (Replaces USAF Form 620, 29 Aug 46)

APPENDIX C

REFERENCES

1. Test Operations Procedure 4-2-055, Fuzes, 3 December 1970.

2. Test Operations Procedure 4-2-805, Projectile Velocity Measurements, 23 April 1979.

3. Test Operations Procedure 3-2-810, Weapon Pressure Measurements, 5 October 1979.

4. Test Operations Procedure 3-2-802, Measurements of Cannon 9 August 1976.

5. Charge, Spotting, Model APG-2, MIL-C-48352(PA), 5 September 1975.

6. Acceptance Test Procedure F-105H/155H/8H-1J, Part 8.5, 3 November 1978.

7. Final Report of Research Test of FY 63 APG Modernization Program, APG Report No. DPS-1677, August 1965.